NHTSA-03-14845-14

26585

Ford Motor Company

James P. Vondale, Director
Automotive Safety Office
Environmental & Safety Engineering

December 19, 2003

Jeffrey Runge, M.D.
Administrator, National Highway Traffic Safety Administration
400 Seventh Street S.W.
Washington, D.C. 20590

Re: Petition for Rulemaking to Amend the Side Impact Dummy (SID) Specifications in 49 CFR Part 572, Sub-part F for use in Federal Motor Vehicle Safety Standard No. 214 and the Lateral Impact New Car Assessment Program

Dear Dr. Runge:

Ford Motor Company (Ford) has identified a mechanical condition associated with the Side Impact Dummy (SID) that erroneously and randomly creates mechanical "noise" and associated data spikes in the SID data traces during dynamic side impact crash tests. This mechanical "noise" or "ringing" is due to metal-to-metal contact between the SID ribcage damper piston and the damper body when the piston is fully extended.

Ford internal testing has identified that for certain vehicle environments in Federal Motor Vehicle Safety Standard No. 214 (FMVSS-214) and/or Lateral Impact New Car Assessment Program (LINCAP) testing, the ribcage damper piston can fully extend during the dummy loading event. When this occurs, the resulting data spikes in the SID responses can register a magnitude and duration such that the resulting Thoracic Trauma Index calculation can be unrealistically high, with the potential to result in a value exceeding the FMVSS-214 limits and/or to reduce a vehicle's LINCAP rating by one or more stars.

Ford, in collaboration with Denton ATD, Inc., has developed modifications for the SID ribcage damper that significantly reduce the effect of the data spikes caused by the metal-to-metal contact between the piston and damper body at full extension. These modifications do not alter the SID response characteristics associated with FMVSS-214 compliance or LINCAP performance (except for reducing or eliminating the ringing from metal-to-metal contact), and will comply with all regulatory SID dummy response calibration requirements.

Ford requests that NHTSA incorporate these damper modifications in the SID specifications and instruct its testing contractors to equip their SID test devices with these modifications for use in all FMVSS-214 and LINCAP evaluations. Ford also requests that NHTSA incorporate the ribcage deflection potentiometer, using the mounting bracket design used by Ford, in the SID specifications. Ford testing has demonstrated that use of the deflection sensor aids in the diagnosis and verification of the metal-to-metal contact condition.

ESAZ-009272

The attached document describes how Ford identified this situation, the development of damper modifications, and the final prove-out of the modifications in a Ford internal LINCAP crash test.

Ford is willing to meet with NHTSA at any time to help expedite rulemaking to resolve this issue. If you have any questions about this petition, please contact Michael Leigh in my office (phone 313-390-7384 or e-mail mleigh@ford.com) from my office.

Sincerely,

James P. Vondale

Attachments

Background

On September 24, 1996, the National Highway Traffic Safety Administration (NHTSA) published a Notice of Proposed Rulemaking (NPRM) to amend the specifications for the side impact test dummy (SID) utilized in Federal Motor Vehicle Safety Standard No. 214 (FMVSS-214). This NPRM was published in the Federal Register Vol. 61, No. 186, Docket Number of 96-098. In this NPRM, NHTSA cited its research testing indicating that the SID ribcage damper piston can have an appreciable effect on thorax accelerations as measured by the SID. NHTSA concluded that if the damper piston was not fully extended prior to a side impact test, the piston can fully extend itself during impact until it is arrested by the piston bottoming out against the damper body. NHTSA test data indicated that this internal "collision" of the damper piston against the damper body can cause inconsistency in data measurements and the determination of acceleration levels. NHTSA stated that the "collision" does not occur when the piston is fully extended within the damper body prior to a side impact test. On April 2, 1998, NHTSA issued a Final Rule amending the SID positioning procedure to ensure proper damper piston configuration prior to a side impact test (Federal Register Vol. 63, No. 63, Docket Number NHTSA-98-3668).

Ford Internal Testing

For several years, Ford has observed the effect of the internal "collision" of the SID damper piston with the damper body in side impact crash tests. Late in the crash event, when the SID is experiencing rebound from the loading of the side impact, the ribcage will fully expand allowing the damper piston to fully extend and bottom out on the damper body. The result of the internal "collision" is mechanical "noise" or "ringing" which manifests itself by creating data spikes in the measured accelerations within the SID. Since this occurrence is after the dummy-loading portion of the crash event, the acceleration values resulting from the internal "collision" are not used for determining dummy performance (e.g., Thoracic Trauma Index, TTI).

Recently, Ford has identified conditions where the mechanical "noise" or "ringing" associated with the full extension of the SID ribcage damper piston can occur during the dummy loading events that take place in FMVSS-214 and Lateral Impact New Car Assessment Program (LINCAP) testing. Generically, this condition occurs when the SID thorax is loaded during a side impact, the load is then released for a short duration of time to the extent that the damper piston can fully extend and bottom out against the damper body (i.e., internal "collision"), and then subsequent loading is applied to the thorax region as the crash event proceeds. Since this *loading/unloading/re-loading* of the SID can occur during the critical portion of the crash test event, Ford has observed that the internal "collision" phenomenon can significantly affect the measured rib and spine accelerations by introducing data spikes and thereby appreciably affecting calculation of the TTI, even with the FMVSS-214 specified FIR filtering process.

Ford initially observed this condition in relation to side airbag loading of the SID thorax in side impact crash tests. In Ford internal LINCAP tests of particular side airbag equipped vehicles, the SID thorax is initially loaded by the airbag positioning between the dummy and the vehicle door, then the thorax loading is relaxed due to the nature of the vehicle deformation and airbag kinematics, thereby allowing the damper piston to fully extend, and then, as the crash event progresses, the loading is re-applied to the thorax. Ford has also observed the *loading/unloading/re-loading* phenomenon in LINCAP tests without the presence of side airbag systems. The phenomenon can occur when the door structure of the vehicle initially loads the SID thorax as the FMVSS-214/LINCAP barrier intrudes, then the loading is relaxed due to the

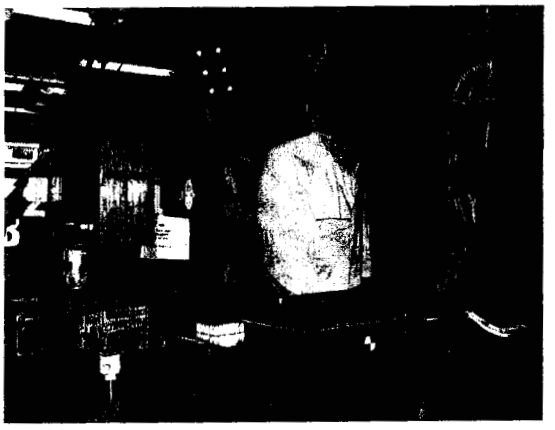
sequence in the 0 to 50 ms time-frame (i.e., the door structure loads the SID, then relaxes the loading due to the vehicle's deformation kinematics, and then re-loads the SID when the dummy rotates outboard and contacts the door structure again). The plot windows for T12, Upper Rib and Lower Rib indicate no data spikes in the 0 to 50ms time-frame for Test B (modified damper), whereas Test A (baseline damper) does indicate data spikes in the same time-frame. The TTI values for Test A and B were 63 and 51 respectively. These TTI values correspond to a LINCAP rear dummy star rating of 4-star for Test A and 5-star for Test B. Ford considers this a very significant difference is performance and believes that such a situation could lead a vehicle manufacturer to unnecessary design changes based on an unrealistic crash dummy response. Design changes to compensate for this artifact would likely not provide any incremental real-world safety benefit. Also demonstrated in Attachment 6 is the fact that the modified damper test (Test B) had no data spikes later in the crash event when the SID is in rebound and the ribcage damper piston fully extends as indicated by the deflection measurement returning to zero (between 190 and 200 ms). Conversely, in Test A, when the ribcage damper piston fully extends during rebound (deflection returns to zero at approximately 170 ms), there are large data spikes due to the internal "collision" between the damper piston and the damper body. Please note that the deflection data trace and the thorax acceleration traces have slightly different x-axis scaling.

Following the crash test, the modified damper and SID were subjected to post-test calibration testing and all responses complied with regulatory requirements.

Summary

Ford laboratory and crash testing has demonstrated that the modified damper design (i.e., internal washer and external spacer) mitigates the internal "collision" artifact. Ford calibration tests of the SID and modified damper indicate that these modifications comply with regulatory requirements. Denton ATD, Inc., has developed a manufacturing feasible modified damper design using Ford's concepts. Ford requests incorporation of the modified damper design into the SID specifications and that all FMVSS-214 and LINCAP evaluations be performed using modified dampers.

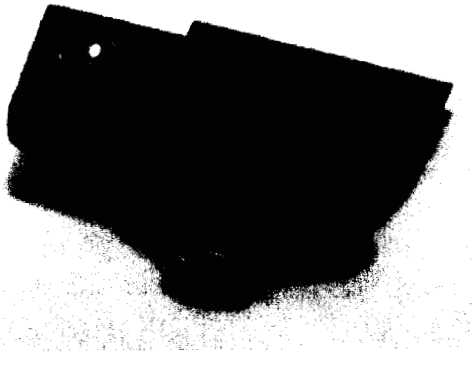
SID Laboratory Impact Test Set-up for Test Series 1 and 2



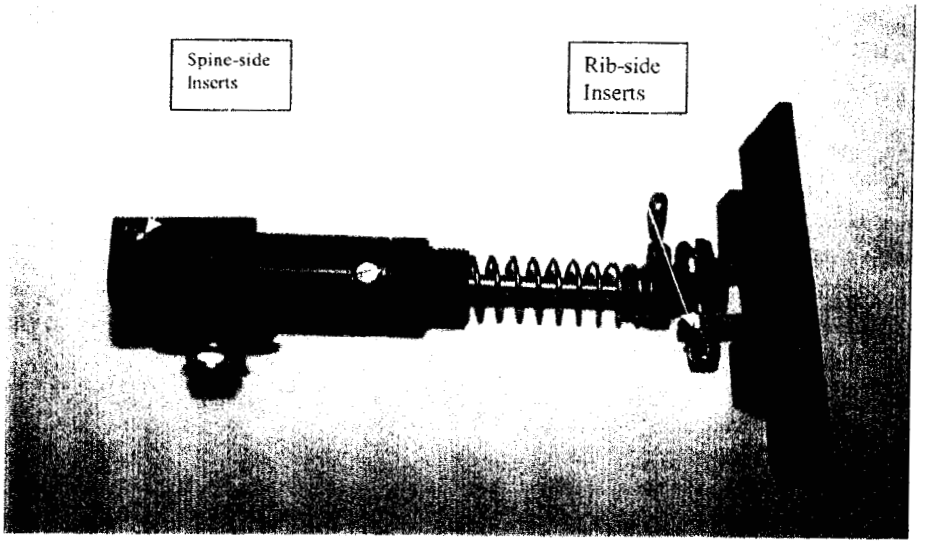
Ribcage Damper Modifications Evaluated in Laboratory Impact Test Series 1

Rib-side inserts

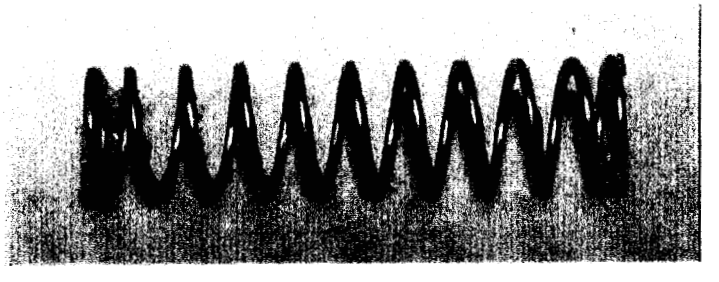
Spine-side inserts



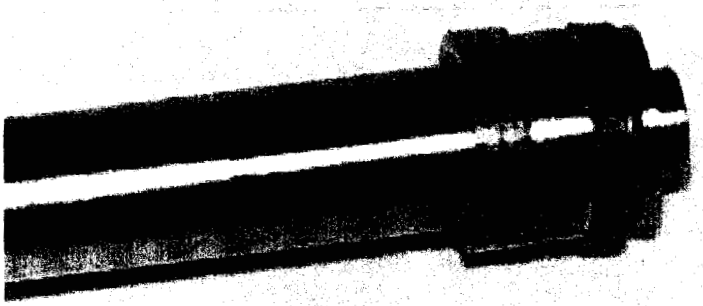
Damper Assembly with Rib- and Spine- Inserts



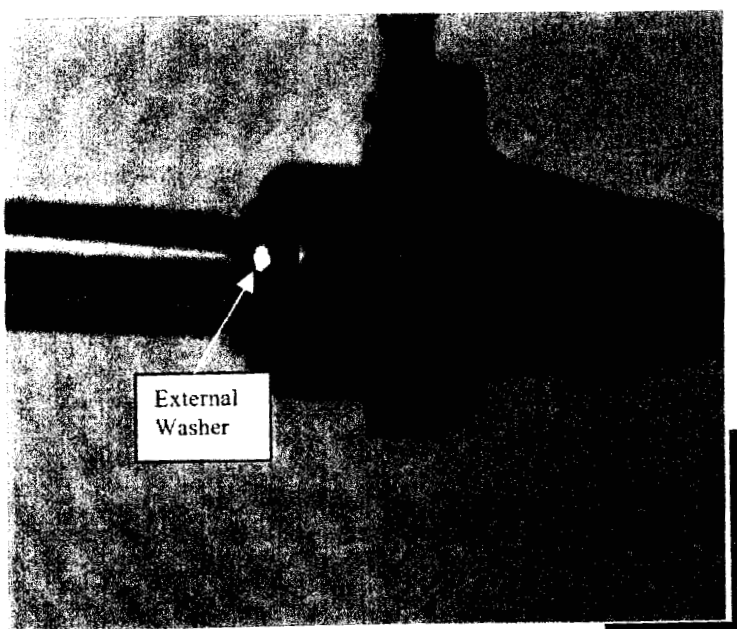
Coated Damper Return Spring

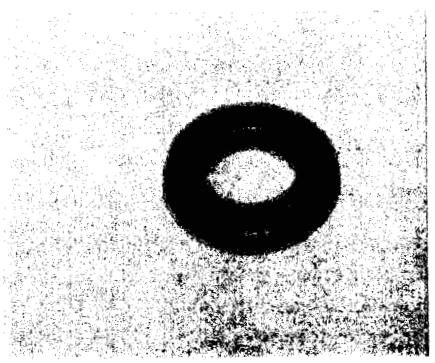


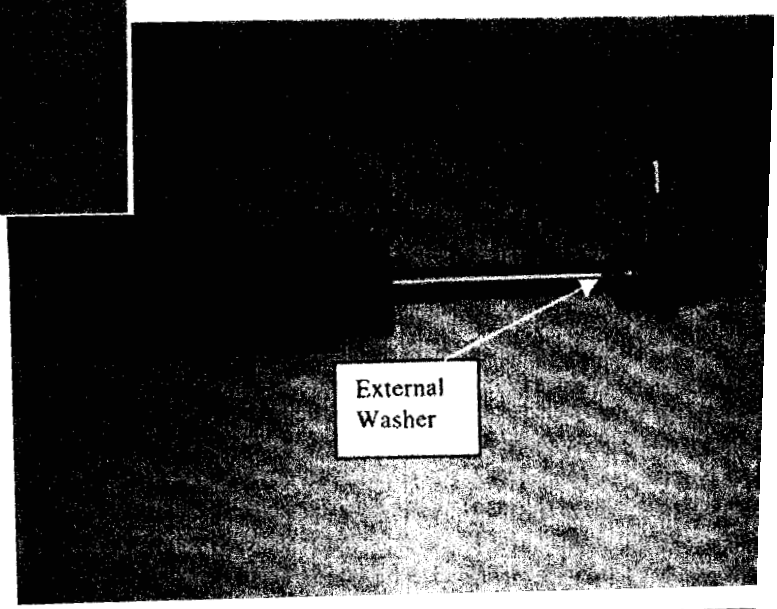
Internal Washer used in Laboratory Test Series 2 and 3 (shown is the nylon washer design by Denton ATD evaluated in test series number 3)



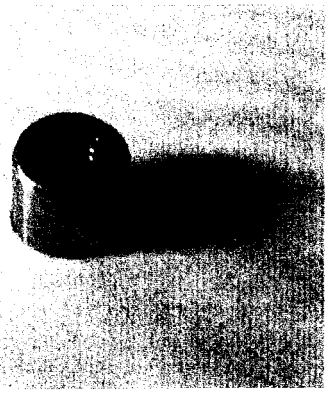
External Washer used for Laboratory Test Series 1



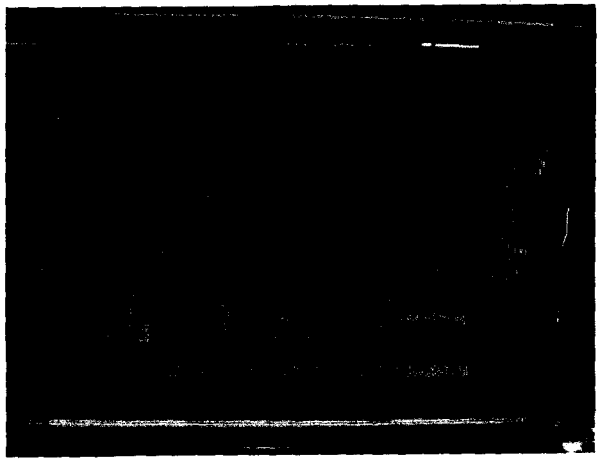




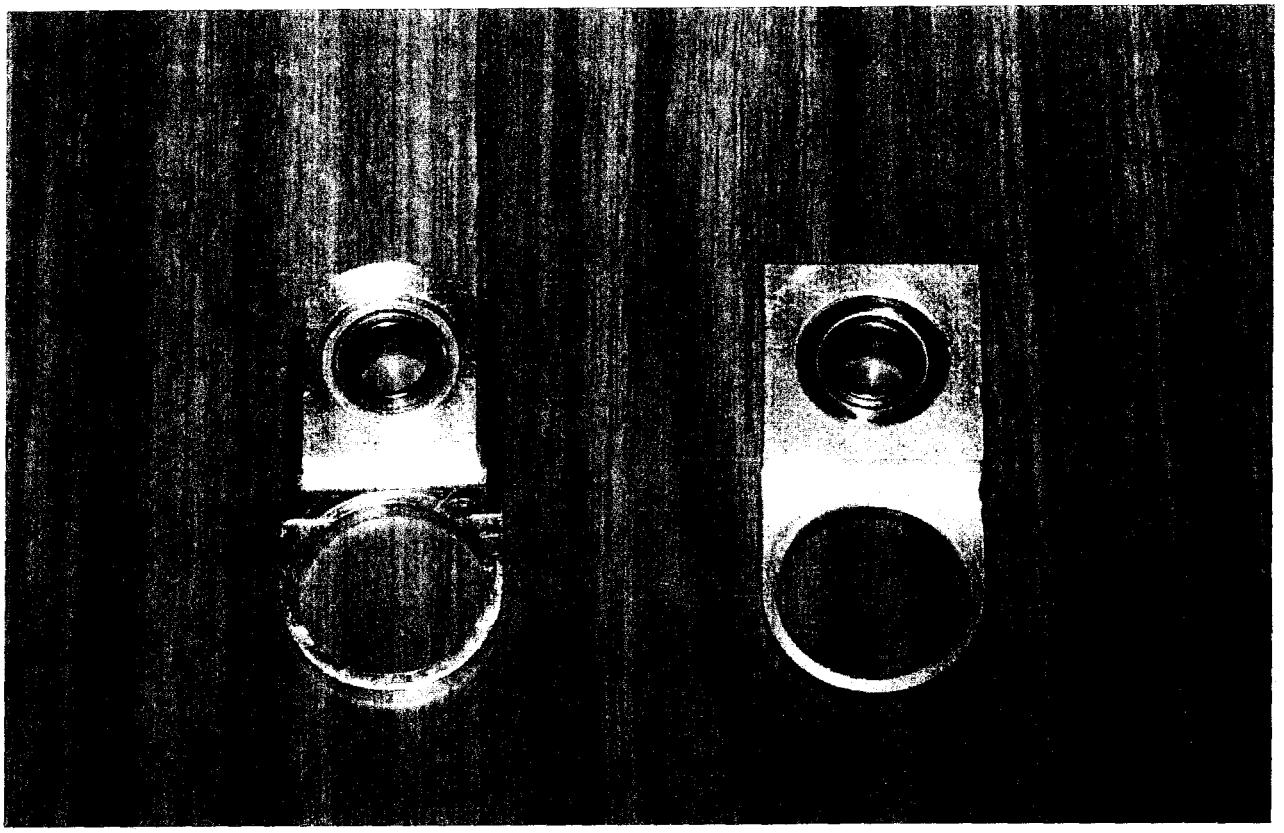
External Spacer used in Laboratory Test Series 2 and 3 (7 mm piece cut from scrap piston shaft)



Laboratory Test Series 3 – Heidelberg Sled Test Set-up



Ribcage Damper Deflection Potentiometer Mounting Bracket (Left is the "modified" design used by Ford, Right is the mounting bracket design that can cause metal-to-metal contact within the SID)



SID Ribcage Damper Assembly with Modified Deflection Potentiometer Mounting Bracket